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THE PROTECTION OF HAWKS AND OWLS IN OHIO.*

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INTRODUCTION.

Among the changes in the world, brought about by the rapid development of methods and ease of communication during the last thirty years, may be seen the entire change of attitude of the farming population toward scientific agriculture. The farmer is no longer inaccessible, lagging behind and lacking in knowledge and news of the day, no longer farming by tradition and the turn of the moon as in the days which some of the eldest of us recall. The Federal and State Biological Surveys, State Colleges, and Experiment Stations have studied into every phase of scientific and practical agriculture, and the farmer, the progressive of today, has learned to accept and apply this information in daily life.

One of the last, but by no means least important, of the questions to receive careful study, and deserving immediate action, is this subject of the protection of our hawks and owls from wanton slaughter. All during our early days we recall how the cry of "hawk" on the farm meant always "chicken hawk" and all hawks were considered "chicken hawks" and, of course, we would run for the gun to destroy the invader.

It was the day of hear-say and tradition, and few of us ever thought to watch the hawk to see what he picked up when undisturbed, and discover that he came not always for the chickens, but frequently for the rats that were killing our chickens.

Of recent years the Federal and State bureaus have diligently gone after the facts in the case, by the examination of stomachs

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of thousands of birds and by other forms of accurate observation, and the results of these studies we have attempted to gather in this paper.

We do this in the belief that the progressive farmer will no longer allow the destruction of these useful birds, and that intelligent sportsmen and game keepers will realize that these birds, as they come over the line, are not necessarily after the game, but come to free the estate of the greatest enemies of game—the rats, mice, and other rodents.

A most interesting example of change in attitude of a population over a great area occurred in Southern Georgia, where our laboratory operated an experiment station at Thomasville for ten years. Between and about Thomasville and Tallahassee are two hundred thousand acres, divided into large plantations, many of them ten thousand acres or more, owned chiefly for game shooting. Delightful in winter climate, a land which cannot compete with the intensive agriculture of other states, but rolling, open fields, with much waste land of some hard wood and some pine, largely fields of thickets and weeds, it is ideal for game shooting which is the chief business of the region.

In 1923 the sportsmen of this region formed a committee, which was called the Cooperative Quail Investigation, and by private subscription raised funds for a five-year study, which was operated by the U. S. Biological Survey with Herbert L. Stoddard in charge.

The sportsmen have published a most complete and able report of this work in "The Bob-White Quail," by Herbert L. Stoddard, offered by Charles Scribner Sons, New York, 1931.

Mr. Stoddard, already an able field naturalist, devoted five years to the study of quail with not only his scientific assistants working upon all phases of life of the bird, but with the hearty cooperation and active assistance of all the owners and game keepers in that great game territory.

That he is now recognized and retained by the sportsmen of the South and East as an able consultant expert justifies our quoting him as to the supposed harm of hawks and owls. Quoting as to certain hawks:

Sparrow Hawk:

"No instance of attack on bob-whites by the sparrow hawk (*Falco sparverius*) came to the attention of the Investigation. . . . In several instances individuals took up quarters temporarily on the fence

posts of propagating enclosures and made forays against the large grasshoppers on the ground beneath, without harming the quail chicks in the least."

Red-tailed Hawk:

"Unless red-tails are unusually numerous they may well be tolerated upon quail preserves because of their usefulness in catching cotton rats and other destructive rodents, and because they eat some snakes, which are the most difficult of quail enemies for man to control."

Red-shouldered Hawk:

"Time devoted to killing these useful birds on the quail preserves is worse than merely wasted, for no instances of quail destruction on their part came to light during the course of the investigation."

Broad-winged Hawk:

"This is one of the wholly beneficial species that should be given full protection at all times. Unfortunately it is so tame and unsuspicious that many are shot under the guise of protecting game or poultry."

Marsh Hawk:

"In view of the fact that not more than four quail were discovered in approximately 1,100 pellets, marsh hawks can hardly be accused of making serious inroads on the number of quail in a region. On the other hand, one or more cotton rats were found in 925 of these pellets. . . . Since cotton rats destroy the eggs of quail, the marsh hawk is probably the best benefactor the quail has in the area, for it is actively engaged in reducing the number of these rodents."

Cooper's Hawk and Sharp-shinned Hawk:

These two are indeed bad actors, both being bird killers and destructive to either birds or game, and Mr. Stoddard advises local control of them. But any attempt at control of these two species must be in the hands of really well informed persons, for, again quoting Stoddard:

"While the majority of hunters and outdoor people probably can tell the fully adult Cooper's and red-shouldered hawks apart, few can differentiate them in their juvenal plumages."

Fortunately in Ohio these two comprise less than eight percent of the hawks found in the State.

Passing now to the report of Stoddard as to owls:

"In view of the fact that the first two species (great horned owl and barred owl) are valuable in keeping skunks, opossums, and rodent enemies of the bob-white within bounds and that all are great enemies of the cotton rats . . . all owls should be regarded as beneficial on quail preserves."

"One of the most discouraging sights seen by us during the Quail Investigation was a beautiful barn owl, hanging by one foot from a steel trap on a quail preserve where cotton rats were abundant. The services of this bird would have been highly valuable to the owner, but its life had been sacrificed by the indiscriminate pole trap, which has no place on a well managed quail preserve."

That we have given so much space to these quotations from the quail fields of Georgia is because these are not the arguments of the so-called "sentimentalists," but the report forms the practical working basis of a great body of sportsmen throughout the southern and eastern states.

It is of interest in this connection to go back seventy-three years to quote John Kirkpatrick writing in the *Ohio Farmer* in 1859, on "The Rapacious Birds of Ohio," as follows:

"Nature is nicely balanced in all her relations and man's interference often does more harm than good. It becomes necessary to weigh judiciously the ultimate consequences of our actions or we may find evil effects when good only were expected."

RODENT PESTS AND CATS.

In many parts of the country it has occurred that the immediate result of the general destruction of hawks is a tremendous increase of rats and mice and other rodents, creatures which are vastly more destructive to birds of all kinds, whether game or song birds, than hawks can be.

With the increase of rodents in fields and homes encouragement is given to the increase of cats, until both song and game birds become victims of the cat pest added to the destruction already caused by the rodents. Both pests do far more damage than could possibly be caused by even the worst of hawks or owls. The Sacred Cat has already the advantage of the seemingly universal superstition that it is unlucky to kill a cat. Because of this superstition the people living in cities and towns, instead of destroying the multitude of surplus kittens, pack them into bags and baskets and drop them promiscuously over the country.

This superstition alone may well account for some of the scarcity of birds and game, instead of blaming it upon the hawks and owls.

ESTHETIC AND CULTURAL IMPORTANCE.

The hawks and owls are of considerable esthetic and recreational importance. An ever increasingly interested public is taking to enjoyments and pleasures out-of-doors in the observance and study of nature. If predatory birds were missing from nature, a very great loss to this group of people would result, as the hawks and owls, because of their size, majestic flight, or conspicuousness, are always of profound interest.

A movement has been on foot for several years to set aside parks and sanctuaries all over the country for the conservation of wild life. It is very desirable on these areas to conserve all the wild life, hawks and owls as well as the rest, so as to leave nature as little disturbed as possible. Nature may be best appreciated and enjoyed by man when it is in as nearly as possible an undisturbed condition. One of the purposes of these areas is to furnish cultural centers to teach man to enjoy to a large degree the natural and undefiled out-of-doors. However, such areas are not always easily accessible to everyone. It is desirable that this conservation be supplemented nearer home. The conservation of the hawks and owls would be one item in such a program.

ABUNDANCE OF HAWKS IN OHIO.

Before ascertaining the food habits of the various species of hawks and owls, it is necessary to consider their abundance in Ohio. This is necessary for any satisfactory judgment of their economic importance. In order to determine the abundance of the various species, resource was had to correspondence with thirty-six ornithologists in the State. A request was made of each observer to compile the number of times he had observed each species each year and then to total the entire number of times he had observed each species for all the years of his observation. Data were also obtained on the number of trips taken by each observer, the number of hours spent in observation, and the total mileage covered.

Twenty people replied to these requests with data and notes. Their names are listed below with the counties in which they made their observations.

MILTON B. TRAUTMAN—All counties in State, particularly Fairfield, Licking, Pickaway, Perry, Franklin, Ottawa and Pike, 1922–1932.

LAWRENCE E. HICKS—All counties of State, 1918–1931.
S. V. WHARRAM—Ashtabula County, 1921–1931.
CLEVELAND BIRD CLUB—Geauga, Lake, Cuyahoga, Lorain, Erie and Ottawa Counties, 1931.
JOHN W. ALDRICH—Notes.
S. CHARLES KENDEIGH—Lorain, Erie, Ottawa Counties, 1920–1930.
LOUIS W. CAMPBELL—Lucas County, 1926–1931.
JIM A. BRUCE—Wayne County, 1928–1931.
EDWIN LINCOLN MOSELEY—Notes.
PAUL A. STEWART—Columbiana and Mahoning Counties, 1927–1931.
MERIT B. SKAGGS—Trumbull and Mahoning Counties, 1922–1932.
WM. C. BAKER—Columbiana and Mahoning Counties, 1929–1932.
E. V. PRIOR—Licking County, 1927–1932.
R. B. GORDON—Franklin County, 1921–1930.
MARGARET M. NICE—Franklin County, 1928–1931.
FLOYD B. CHAPMAN—Franklin, Fairfield, Licking, Hocking, and Delaware Counties, 1924–1932.
PAUL FORSTHOEFEL—Mercer County, 1925–1932.
BEN J. BLINCOE—Montgomery, Green and Miami Counties, 1923–1931.
WM. C. HERMAN—Notes.
CONRAD ROTH—Scioto and Adams Counties, 1926–1931.

The southern and southeastern parts of the State are not so well covered as the rest, but since two observers have studied in all the counties in the State while the other observers are fairly well scattered over the State, one is justified in believing that the relative abundance of the species, as given below, is representative.

A compilation of all the records sent in by the observers was made. These records are from seventeen observers covering the years 1918 to 1932. The total number of trips after birds taken by these ornithologists during this period was 6,902; the total number of hours spent in the field in observation was 39,095; while the total mileage covered was 180,142. The size of these totals is impressive, and since they were made by the best trained people in the state for the careful and exact identification of birds, they have considerable value.

In Table I, the number of times which each species of hawk was observed and its relative abundance are expressed.

Almost exactly half of all the hawks observed were sparrow hawks. This species was by far the most common one. The marsh hawk ranks next, followed by the red-shouldered and red-tailed hawks. These species are all decidedly beneficial to the farmer and sportsman. From the economic standpoint, more complaints have been lodged against the Cooper's, sharp-shinned, pigeon, duck, and goshawks than against any of the

others. Yet these five species together make up only 8.7% of the entire hawk population in the State. The other 91.3% of the hawk population is made up of species generally recognized by scientists to be beneficial. In other words, there are in the state of Ohio, over ten recognized beneficial hawks to every one that may be considered less desirable. The good done by the ten overbalances by far the harm done by the one, and gives a clear indication of the great economic importance of hawks to the farmer and sportsman in Ohio.

TABLE I.

RELATIVE ABUNDANCE OF HAWKS IN OHIO.

Species	Number of Times Recorded	Percent of Total Number Hawks Recorded
1. Sparrow Hawk	10,913	50.5%
2. Marsh Hawk	3,918	18.2
3. Red-tailed Hawk	1,946	9.0
4. Red-shouldered Hawk	1,640	7.6
5. Cooper's Hawk	1,168	5.4
6. Sharp-shinned Hawk	498	2.3
7. Broad-winged Hawk	369	1.7
8. Osprey	351	1.6
9. Bald Eagle	351	1.6
10. Rough-legged Hawk	272	1.3
11. Pigeon Hawk	86	0.4
12. Duck Hawk	57	0.3
13. Goshawk	32	0.1
14. Golden Eagle	5	0.02
Total	21,606	

ABUNDANCE OF VULTURES IN OHIO.

The turkey vulture and black vulture are sometimes mistaken for hawks by the uninformed. Both species are scavengers, living chiefly on dead and decaying matter, and so are of no harm to either the farmer or sportsman.

On the basis of the bird census described above, 25,703 turkey vultures and 357 black vultures were reported for the same period of time and over the same territory as were the hawks observed. The combined total of all species of hawks observed was 21,606, which is more than four thousand *less* than the number of times that the turkey vulture alone was observed. This beneficial species is a very important one, therefore, in a consideration of the bird life of Ohio. The black

vulture is far less common and confined entirely to the southern part of the State. The turkey vulture is also more common southward although generally distributed over the State.

ABUNDANCE OF OWLS IN OHIO.

Owls are much more difficult to locate and observe than are the hawks and vultures. In the census reports from seventeen observers which was described above, a combined total for all species amounting to only 3,585 individuals was observed, (Table II).

TABLE II.

RELATIVE ABUNDANCE OF OWLS IN OHIO.

Species	Number of Times Recorded	Percent of Total Number Owls Recorded
1. Screech Owl	1,672	46.6%
2. Barn Owl	558	15.5
3. Great Horned Owl	517	14.4
4. Barred Owl	450	12.6
5. Short-eared Owl	284	7.9
6. Long-eared Owl	52	1.5
7. Snowy Owl	28	0.8
8. Saw-whet Owl	24	0.7
Total	3,585	

The screech owl is by far the most abundant, the barn owl comes next, then the great horned owl and barred owl. The great horned owl which is sometimes destructive to poultry and game animals makes up only 14.4% of the total owl population. The other species are generally to be rated beneficial. Their combined total amounts to 85.6%. Thus, there are nearly six beneficial owls to each one that may sometimes be destructive. The economic status of the general owl population must be rated high.

FOOD HABITS.

Considerable study has been made by the Biological Survey, Department of Agriculture, Washington, D. C., and others, of the food habits of the various species of hawks and owls in the United States. Only when one knows the kind of food upon which the various species of hawks and owls feed, can one properly judge their exact economic importance. An attempt

has been made to summarize the available information on the nature of the stomach contents of all the species of hawks and owls that occur in Ohio, (Warren, 1890; Fisher, 1893).

TABLE III.

TYPES OF FOOD CONSUMED BY VARIOUS SPECIES OF HAWKS AND OWLS.

TURKEY VULTURE AND BLACK VULTURE.

Henderson (1927) states that these species feed chiefly on carrion. The turkey vulture also takes some snakes, toads, rats, mice, and occasionally young birds.

MARSH HAWK.

Stomachs examined—144.

Mice and other small mammals	54.9%
Small birds	23.6
Insects	9.7
Reptiles and batrachians	6.2
Poultry and game birds	4.9
Indeterminate	0.7

SHARP-SHINNED HAWK.

Stomachs examined—116.

Small birds	85.3%
Poultry and game birds	5.2
Mice and other small mammals	5.2
Insects	4.3

COOPER'S HAWK.

Stomachs examined—103.

Small birds	50.5%
Poultry and game birds	33.0
Mice and other small mammals	10.7
Lizards	2.9
Insects	1.9
Frogs	0.1

GOSHAWK.

Stomachs examined—25.

Mice and other small mammals	40.0%
Poultry and game birds	36.0
Insects	12.0
Small birds	8.0
Centipeds	4.0

RED-SHOULDERED HAWK.

Stomachs examined—398.

Mice and other small mammals	47.5%
Insects	23.1
Reptiles and batrachians	17.6
Spiders	4.0
Small birds	3.0
Crayfish	1.7
Fish	1.5
Poultry and game birds	0.7
Offal	0.5
Earthworms	0.2

RED-TAILED HAWK.

Stomachs examined—792.

Mice and other small mammals	69.6%
Poultry and game birds	9.0
Small birds	7.2
Insects	5.9
Reptiles and batrachians	5.0
Offal	0.2
Crayfish	0.1

BROAD-WINGED HAWK.

Stomachs examined—102.

Mice and other small mammals	31.4%
Insects	29.4
Reptiles and batrachians	27.4
Small birds	4.9
Crayfish	4.9
Earthworms	2.0

ROUGH-LEGGED HAWK.

Stomachs examined—58.

Mice and other small mammals	96.5%
Insects	1.7
Reptiles and batrachians	1.7

DUCK HAWK.

Stomachs examined—20.

Small birds	50.0%
Poultry and game birds	35.0
Insects	10.0
Mice and other small mammals	5.0

PIGEON HAWK.

Stomachs examined—61.

Small birds	67.2%
Insects	26.2
Mice and other small mammals	3.8
Poultry and game birds	3.8

GOLDEN EAGLE.

Stomachs examined—5.

Mice and other small mammals	40.0%
Carrion	40.0
Birds	20.0

BALD EAGLE.

Stomachs examined—17.

Fish	52.9%
Mice and other small mammals	29.4
Carrion	11.8
Game birds and poultry	5.9

TABLE III—[*Continued*]

TYPES OF FOOD CONSUMED BY VARIOUS SPECIES OF HAWKS AND OWLS.

SPARROW HAWK.

Stomachs examined—476.

Insects	50.2%
Mice and other small mammals	25.4
Small birds	13.0
Spiders	6.1
Reptiles and batrachians	2.5
Game birds	0.2

OSPREY.

Stomachs examined—11.

Fish	100.0%

BARN OWL.

Stomachs examined—47.

Mice and other small mammals	83.0%
Insects	8.5
Small birds	8.5

Pellets examined (*)

Number of skulls identified from Ohio—8,672

Mice and other small mammals	98.7%
Small birds	1.3

LONG-EARED OWL.

Stomachs examined—129.

Mice and other small mammals	86.0%
Small birds	11.6
Insects	1.6
Poultry and game birds	0.8

Pellets examined (†)

Number of skulls identified—88

Mice and other small mammals	95.7%
Small birds	4.3

GREAT HORNED OWL.

Stomachs Examined—134.

Mice and other small mammals	62.0%
Poultry and game birds	23.1
Insects	7.5
Small birds	6.0
Fish	0.7
Scorpions	0.7

SHORT-EARED OWL.

Stomachs examined—114.

Mice and other small mammals	83.3%
Small birds	10.5
Insects	6.1

BARRED OWL.

Stomachs examined—122.

Mice and other small mammals	56.5%
Insects	11.5
Small birds	11.5
Crayfish	7.4
Poultry and game birds	5.7
Frogs	3.3
Fish	1.6
Spiders	1.6
Lizards	0.8

SAW-WHET OWL.

Stomachs examined—26.

Mice and other small mammals	73.0%
Insects	23.1
Sparrows	3.8

SCREECH OWL.

Stomachs examined—300.

Mice and other small mammals	40.6%
Insects	34.0
Small birds	14.7
Crayfish	3.0
Miscellaneous	2.3
Reptiles and batrachians	2.0
Spiders	1.7
Scorpions	0.7
Earthworms	0.7
Fish	0.3

SNOWY OWL.

Stomachs examined—26.

Mice and other small mammals	64.5%
Small birds	29.0
Game birds and poultry	6.5

*Examinations by Roscoe W. Franks and Arthur Stupka.
†Examinations by the Wheaton Club, of Columbus, Ohio.

FOOD CONSUMPTION.

After considering the food habits of the different species of hawks and owls it is useful to summarize these data for all hawks together and all owls together. This furnishes a better criterion as to the actual amounts and kinds of food consumed by all birds of prey in Ohio, and enables us to judge better the

economic status of our hawk and owl population taken as a whole. These summaries are given in Tables IV and V.

The percentages in these two tables were arrived at in the following way. It was desirous to determine the percentage of each type of food in the total amount consumed by all hawks and by all owls in the State. In order to arrive at such figures, the relative abundance of each species (Tables I and II) had to be considered so that the types of food consumed by the more abundant species may carry proportionally more weight than the type of food consumed by the less common species. For instance, poultry and game birds make up 33.0% of the food of the Cooper's hawk, but the Cooper's hawk constitutes only 5.4% of the entire hawk population, so multiplying these two figures together and dividing by 100 gives 1.8% as the actual proportion of the entire food consumption of all hawks which this food habit of the Cooper's hawk represents.

Then again, mice and other small mammals make up only 25.4% of the food of the sparrow hawk. This is however, the most abundant hawk in the State (50.5%), so this food habit of this single species amounts to 12.8% of all the food consumed by all the hawks in the State. When these percentages are worked out for each type of food and for each species, the total combined results occur as given in the following two tables (IV and V).

TABLE IV.

ANALYSIS OF TOTAL FOOD CONSUMPTION BY ALL HAWKS IN OHIO.

Mice and other small mammals	35.7%
Insects	30.3
Small birds	16.9
Poultry and game birds	4.8
Reptiles and batrachians	4.8
Fish	2.6
Centipeds, offal, crayfish, spiders, scorpions, earthworms, and indeterminate	4.0

TABLE V.

ANALYSIS OF TOTAL FOOD CONSUMPTION BY ALL OWLS IN OHIO.

Mice and other small mammals	57.3%
Insects	20.4
Small birds	12.0
Poultry and game birds	4.1
Reptiles, amphibia, centipeds, crayfish, spiders, scorpions, earthworms, offal, fish, and miscellaneous	7.0

In looking over the records of stomach examinations for the various species in Table III, one may be inclined to conclude

that the Cooper's hawk, sharp-shinned hawk, goshawk, duck hawk, and pigeon hawk are very destructive predators, but when the food habits of the hawks, as a group, are studied with relation to their relative abundance, as in Table IV, we find that the amount of poultry and game birds eaten make up only a very small fraction (4.8%) of the diet. This fact is more sharply emphasized in the food studies of the owls. In this group the great horned owl does more damage than all the other species of owls combined, yet only 4.1% of the entire food of all the owls consists of game birds and poultry. We may charge up to the hawks and owls the 4.8% and 4.1% respectively of their diet taken from the supply of game birds and poultry, but we must also credit them with taking 66.0% and 77.7% respectively of their diet from our abundant supply of insects, mice, and other small rodents.

The insects eaten by the predaceous birds consist largely of grasshoppers and other large vegetarian forms and for this reason are placed on the credit side of the ledger of these birds.

The hawks and owls make up 16.9% and 12.0%, respectively, of their diet from small birds which are primarily seed and insect eating forms. This, in itself, is not of as great significance as may, at first, appear. The economic status of our smaller birds is not clearly known, because the relative value of the different kinds of food consumed is not well established. Do the insectivorous birds feed more on harmful forms of insects than on beneficial forms? Are they selective in their feeding habits? Do they avoid or destroy parasitic insects which are probably even more potent than are birds in holding the insect population in check? Undoubtedly, seed-eating birds consume immense numbers of weed seeds each year and act as one environmental agent in the balance of nature. However, are not natural competition among the weeds and plants themselves, together with climatic conditions, more potent factors in determining their abundance? Probably few of our small birds are entirely beneficial or entirely harmful in their food habits.

The food habits of some of the mice and other small rodents should be given careful consideration. If the feeding habits of these animals preyed upon by the predacious birds were wholly beneficial to man, then the birds of prey would be undesirable citizens. However, almost without exception, the

entire supply of food consumed by the mice and other small rodents is a direct loss to man. The field mice are abundant throughout the world and subsist upon field crops where they are available.

In the United States Department of Agriculture Year Book, 1917, we find the value of crops destroyed annually by rodents in the United States was estimated to be in excess of $150,000,000. This does not include the losses inflicted by house mice and common brown rats. In the same report we find the damage done in the State of Montana ran between fifteen and twenty million dollars, in Kansas twelve million, in North Dakota from six to nine million, and in California twenty million. In Wyoming, fifteen percent of all crops were destroyed by rodents. If the crops destroyed by rodents could be sold on the market, the return from this source would be sufficient to pay all the farmers' taxes.

Laboratory experiments by Bailey, 1924, reveal that the short-tailed field mice will eat on an average an amount per day equivalent to 107% of their own body weight when fed grass, clover, and cantaloupe rinds. Taking the average body weight of this species at thirty grams, Bailey figures that it will require 10,950 grams (23 pounds) of green food to feed each field mouse one year. He also states that 2,300 pounds of green grass or clover will produce one half ton of dry hay.

With these figures as a basis, we can arrive at the actual value of barn owls to agriculture. One pair of barn owls nesting in a sycamore tree came to the writers' attention February 13, 1927. Pelletts regurgitated in this tree were collected regularly over a period of two months time and their contents identified. During this time 518 mouse and shrew skulls and three sparrow skulls were left by the two owls. On this basis it would be conservative to say that one pair of barn owls will kill on an average 3,000 mice per year.

Using Bailey's figures for the amount of food consumed by field mice, we find three thousand mice would destroy 69,000 pounds of green feed per year, and that 69,000 pounds of green grass or clover is equivalent to 15 tons of dry hay. Assuming that one-half of this is of value to the farmer, the potential value of a single pair of barn owls is equivalent to 7½ tons of hay per year. Hay is worth on an average about $10.00 per ton. Therefore, the potential value of a pair of barn owls to agriculture is $75.00 per year.

Rodents are also among the worst pests with which the sportsman has to deal. Rodents destroy the eggs and young of game birds (Stoddard, 1931, p. 424).

The potential rate of reproduction of the field mouse is extremely high, and under favorable conditions the numbers may soon reach the state of a plague. Bailey's laboratory experiments clearly demonstrated this fact. He found that the first litter may come when the female is forty-five days old, and that the gestation period is twenty-one days. There are usually four young in the first litter, but six to eight in later ones. One female in captivity raised seventeen litters in one year, including 83 young, and remained in normal health. If all the progeny should live and reproduce at the same rate, one million individuals would be produced in one year. Under ordinary circumstances in a state of nature, the young do not all live. Nevertheless, when natural checks were removed, there have been many serious mouse plagues in this country and in many foreign countries.

CONTROL OF RODENT PLAGUES.

A brief review of some of the more serious rodent plagues in the United States and in Great Britain will serve to indicate the extreme importance of the predatory birds in keeping the numbers of the smaller mammals within bounds.

If the natural and normal checks against too rapid multiplication of rodents are removed, great damage results. As an example of what might happen in Ohio, due to killing off the predatory birds, the recent outbreak of the common house mouse, *Mus musculus*, in Kern County, California, in January, 1927, may be described (Hall, 1927).

"At the source, the dry bed of Buena Vista Lake, the writer found as many as 17 mice per square yard over an area of many acres in extent in the kafir corn field. Computed from the counts made on the measured areas, one arrives at the startling number of 82,280 mice per acre. This gives 2,668 pounds of mice per acre, figuring that $33\frac{1}{3}$ house mice weigh one pound.

"Grain bins that I saw had literally thousands swarming about in them; haystacks sheltered nearly as many; and the fields, since they had not been grazed by domestic stock, sheltered millions more. In one grain bin 20 feet square, that was two-thirds full of sacked barley, it was computed that 3,520 mice were in sight at one time. These were on the surface of the grain, on rafters, and on the pole plates. Many times this number unquestionably were out of sight in and among the sacks of grain. At night, on the highway that passes along the

north shore of Buena Vista Lake, the illumination from the headlights of one's car revealed hundreds of live mice at any given instant."

"Actual damage that the mice were seen to do included the destruction of quantities of stored grain; the reduction of large stacks of hay (really straw stacks that are here used for hay) to mere piles of chaff, thus rendering them totally unfit for stock food; the destruction of foodstuffs, clothing, bedding, linen, etc., in the houses; and the gnawing of holes through the floors and walls of frame buildings. It seems probable that the mice would damage growing crops although certainly not to the extent that equal numbers of meadow mice (*Microtus*) would. The house mice constitute a general nuisance on numerous counts. Many people have a general horror, on no specific grounds, of such vast hordes of mice. . . . Where large numbers of mice congregate, as in grain bins and haystacks, the stench arising from the voided body excrements is highly offensive and nauseates many persons. In one observed instance a laborer working at a haystack was so nauseated by the stench from the mice as to vomit severely. In buildings that are not mouse-proof, persons commonly have their sleep interrupted by the numbers of mice that run about over the bedding. On arising in the morning mice are not infrequently found in one's clothing and shoes. During the day, even, when going about ordinary tasks, mice on occasion enter one's clothing. All these things, together with the actual damage done by the mice, naturally have caused considerable concern among the people living in the infested area."

"Hawks, owls, and ravens were more abundant here than usual, due to a movement into the infested area. . . . Named in order of their abundance from first to last; the hawks noted were: Marsh Hawk (*Circus hudsonius*), Western Red-tailed Hawk (*Buteo borealis calurus*), Desert Sparrow Hawk (*Falco sparverius phalaena*), and a rough-legged hawk (*Archibuteo*, sp.?). Barn Owls (*Tyto pratincola*) were abundant, and Short-eared Owls (*Asio flammeus*) were seen wherever there was terrestrial cover, a condition that obtained only at the western end of the lake. . . . Ravens (*Corvus corax sinuatus*) were present in flocks of 15 to 40 and fed on the mice. . . . Although predatory birds were abundant, predatory mammals were extremely rare in the infested area."

Other severe mouse plagues have occurred in various regions. In 1907–08, in Humboldt Valley, Nevada, there was an outbreak of field mice (*Microtus montanus*) that did considerable damage (Piper, 1909). Here it was estimated that there were from 8,000 to 12,000 short-tailed field mice to each acre. The fields were riddled by their burrows which were scarcely a step apart and over a large area averaged 150 to 175 to the square rod. The Humboldt Valley is occupied by a number of large ranches. At the time the plague began there were about 20,000 acres in alfalfa. Within a year and a

half of that time more than 16,000 acres had been destroyed by the mice. This loss to the farmers in the one valley alone amounted to $300,000 in two seasons. This serious plague was finally checked by the natural enemies of the rodents and by poison.

The striking evidence of the valuable services of the natural enemies of mice seen during this plague is but an example of their constant value. Hawks, owls, gulls, crows, ravens, herons, and shrikes among the birds, and coons, coyotes, foxes, weasels, badgers, and wildcats among the mammals, habitually prey upon field mice and are most valuable in preventing undue increase of these pests. In the Nevada valleys all species of hawks and owls are distinctly beneficial, and their rigorous protection has been strongly advocated.

In the report of the 16th American Game Conference (1929) we find that there has been a bounty on owls and hawks in Virginia for twenty years, and along with the depletion of the birds of prey there has been a corresponding increase in pine and short-tailed field mice. These mice are now so abundant in the Virginia orchards and nurseries that they have become an irresistible scourge and each year are wiping out many fortunes and making orcharding impossible in that State. Quoting from Dr. A. K. Fisher, "They are paying out a large sum to protect a potential thousand dollars of game, and probably losing several millions of dollars worth of agriculture."

Mr. Max Hart, secretary of the Virginia Game and Fish Commission, while speaking before the last American Game Conference (1931) hit the keynote with reference to vermin control. Referring to Virginia, Mr. Hart says that in the past ten years we have spent $200,000 on vermin control, but we have just about reached the conclusion that we have got to take that money that we are paying for vermin and buy game birds with it, and put them back in the fields and stop paying bounties on birds of prey. With all of their campaigning against "vermin," the Virginians have learned that killing off hawks and owls will not bring back the game birds.

A perfect example of what constant trapping of all predatory birds and mammals will do by way of removing all checks on the increase of field mice, can be seen on our own State game farm at Wellington, Ohio. On this farm a rigid and extensive campaign of trapping and shooting hawks and

owls is maintained throughout the year without regard or knowledge of the species taken. The game keeper's report to the Division of Conservation made on January 15, 1930, reveals that from March 1, 1929, to the date of the report, 213 hawks and 171 owls were killed on the farm. It is not likely that this number of predatory birds was attracted to the game farm by the game birds that were there, but by the countless thousands of field mice, with which the farm was literally teeming. A walk across the fields revealed the most abundant supply of these rodents ever seen by the writers. Mice could be seen almost constantly as they ran from under foot.

The game keepers of Great Britain are responsible for practically exterminating the hawks and owls on the islands (Adair, 1893; Maxwell, 1893; Middleton, 1930). Due to the almost total absence of predatory animals, Great Britain's vole plagues have been gradually and rapidly increasing for the past thirty years. During 1929 there were eleven major plagues scattered throughout the Islands.

The good work of the hawks and owls in destroying insects, mice, and other small rodents does not consist of breaking up plagues of these forms after they are once beyond control, but by the prevention of plagues arising, by the killing of millions of individuals long before the plague stages begin to threaten.

Here in Ohio we can well afford to spare an occasional game bird or chicken, if need be, to prevent rodent plagues such as occur every four years in Great Britain.

CONTROL MEASURES.

The above information shows clearly that the general hawk and owl population in Ohio have beneficial food habits and are powerful agents in the natural control of rodents. It is not best to distinguish too closely between species, because they all exert some important, controlling influence in nature, and the average person is not able to identify the different forms nor able to properly judge between the beneficial and harmful species. It is rather best to pass judgment on the hawk population as a whole and the owl population as a whole and base our state control measures upon whole populations rather than on each species separately.

If a general campaign against all hawks and owls were undertaken, the average person unable to discriminate between

species would very probably destroy ten beneficial hawks to one harmful one, nearly six beneficial owls to one harmful one, and would probably destroy as many beneficial vultures (if he could come within gun range) as he would all the hawks and owls together. Since the hawk and owl population is predominantly beneficial, such a general campaign should be made legally impossible.

As an illustration of the type of results that are obtained when state-wide eradication is attempted of some species and not others, the recent experience of Pennsylvania in 1929 may be cited. A bounty law was passed providing $5.00 on all goshawks taken in the State. Within one year after the law went into effect, 503 birds were taken into the office of the Pennsylvania Game Commission at Harrisburg in order to secure the $5.00 bounty. Out of this 503 birds only 76, or 15%, were goshawks. Over 58% of all the birds taken were of beneficial varieties.

TABLE VI.

SPECIES AND NUMBER OF INDIVIDUALS KILLED IN STATE-WIDE ERADICATION CAMPAIGN AGAINST THE GOSHAWK IN PENNSYLVANIA.

Red-tailed Hawk	165
Cooper's Hawk	120
Red-shouldered Hawk	84
Goshawk	76
Marsh Hawk	28
Sharp-shinned Hawk	9
Rough-legged Hawk	7
Sparrow Hawk	4
Broad-winged Hawk	3
Duck Hawk	3
Pigeon Hawk	1
Osprey	1
Short-eared Owl	1
Great Horned Owl	1

Several years ago when a hawk law was in force in Ohio, the township clerk at Wakeman issued 86 bounty certificates. Of these 86 hawks killed, 46, or 53.5%, were sparrow hawks, which is a very beneficial species (Fisher, 1907, p. 9). This is to be expected in indiscriminate shooting of hawks, since our census indicates that 50.5% of all hawks which one may meet in the field belong to this species. Such activities soon bring species on the verge of extinction, with the resulting dangers from rodent plagues. Control measures designed to eliminate certain species and not others are distinctly and unquestionably *inadvisable.*

Certain states, notably Pennsylvania, have undertaken in bygone times state-wide campaigns for the eradication of hawks and owls. The great economic loss which these campaigns have meant to the state is well summarized in the Report of the Commissioner of Agriculture for 1886 (Merriam, 1887):

"On the 23d of June, 1885, the legislature of Pennsylvania passed an act known as the 'scalp act,' ostensibly 'for the benefit of agriculture,' which provides a bounty of fifty cents each on Hawks, Owls, Weasels, and Minks killed within the limits of the State, and a fee of 20 cents to the notary or justice taking the affidavit.

"By virtue of the act about $90,000 has been paid in bounties during the year and a half that has elapsed since the law went into effect. This represents the destruction of at least 128,571 of the above mentioned animals, most of which were Hawks and Owls.

"Granting that five thousand chickens are killed annually in Pennsylvania by Hawks and Owls, and that they are worth 25 cents each (a liberal estimate in view of the fact that a large proportion of them are killed when very young), the total loss would be $1,250, and the poultry killed in a year and a half would be worth $1,875. Hence it appears that during the past eighteen months the State of Pennsylvania has expended $90,000 to save its farmers a loss of $1,875. But this estimate by no means represents the actual loss to the farmer and taxpayer of the State. It is within bounds to say that in the course of a year every Hawk and Owl destroys at least one thousand mice, or their equivalent in insects, and each mouse or its equivalent so destroyed would cause the farmer a loss of two cents per annum. Therefore, omitting all reference to the enormous increase in the numbers of these noxious animals when nature's means of holding them in check has been removed, the lowest possible estimate of the value to the farmer of each Hawk, Owl and Weasel would be $20 a year, or $30 in a year and a half."

"Hence in addition to the $90,000 actually expended by the State in destroying 128,571 of its benefactors, it has incurred a loss to its agricultural interests of at least $3,857,130, or a total loss of $3,947,130 in a year and a half, which is at the rate of $2,631,420 per annum! In other words, the State has thrown away $2,105 for every dollar saved! And even this does not represent fairly the full loss, for the slaughter of such a vast amount of predaceous birds and mammals is almost certain to be followed by a correspondingly enormous increase in the numbers of mice and insects formerly held in check by them, and it will take many years to restore the balance thus blindly destroyed through ignorance of the economic relations of our common birds and mammals."

It is conceivable that locally on game farms, in poultry yards, and similar places, a certain amount of protection against preying individuals of some species of hawks and owls may be necessary. Individual birds occasionally acquire

devastating habits, and their elimination is justified. One must make sure, however, that hawks visiting poultry yards are not after rats and mice rather than chickens. Such few individuals, however, by no means condemn the species as a whole nor warrant general campaigns of eradication.

In the protection of local areas, care must be taken in selecting the proper method of defense. Poisoned bait is not recommended because of the great danger to which it exposes other species.

Likewise, the pole-trap is distinctly not advised because it does not distinguish between individual birds bent on destruction from others. Wight (1931) discusses the use of pole-traps on state game refuges in Michigan and shows clearly that they are much more detrimental to beneficial species, including many of the smaller song birds, than they are to the few harmful species of hawks and owls.

Some other method should be used as a control measure. Probably the use of the shotgun on hawks and owls caught in the act of stealing is the safest and best method.

CONSERVATION MEASURES.

In 1928, Hadley reported on the legal status of hawks and owls in the United States at large. Thirty-four states at that time gave some protection to hawks and owls, usually discriminating between species that were sometimes harmful and those which were beneficial. In an attempt to determine how effectively these laws were enforced, Hadley sent a questionnaire to the game commissioners in each state. The general consensus of opinion was that these laws were unenforceable, particularly when it came to protecting some species and not others.

In view of the difficulty of the average person in distinguishing between the various species, a law giving protection to some species and not to others is impracticable and impossible to enforce. The solution is, of course, to create a law giving the same consideration to all species equally. If a study of all the hawks and owls over the State should show that they are predominantly harmful, no protection needs to be offered any species. If, on the other hand, such a study should show that they are predominately useful, then it is best to give equal protection to all. This study indicates strongly that the latter condition is the true one.

The conclusion is warranted, therefore, that the state legislature is amply justified, on the basis of scientific data available, to adopt a law giving rigid protection to all hawks and owls over the State. A clause may be inserted in such a law permitting special control against devastating hawks or owls in local regions, but eliminate, entirely, all possibility of general state-wide campaigns for destruction.

BIBLIOGRAPHY.

The following references to literature dealing with hawks and owls by no means include all that are available, but represent significant and important contributions with which students of conservation should be familiar.

Adair, Peter. 1893. Notes on the disappearance of the short-tailed field vole (*Arvicola agrestis*), and on some of the effects of the visitation. The Annals of Scottish Natural History, Vol. 2.

American Game Protective Association. 1929. Transactions of the sixteenth American Game Conference. New York.

1931. Transactions of the eighteenth American Game Conference. New York.

Bailey, Vernon. 1924. Breeding, feeding, and other life habits of meadow mice (Microtus). Journal of Agricultural Research, Vol. 27, No. 8.

Hadley, Alden H. 1928. The legal status of hawks and owls: a statistical study. Transactions of the Fifteenth National Game Conference.

Hall, E. Raymond. 1927. An outbreak of house mice in Kern County, California. University of California. Publications in Zoology, Vol. 30, No. 7, pp. 189–203.

Hausman, Leon Augustus. 1927. The hawks of New Jersey and their relation to agriculture. Bulletin 439, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

Henderson, Junius. 1927. The practical value of birds. New York.

Fisher, A. K. 1893. The hawks and owls of the United States in their relation to agriculture. Bulletin No. 3, Division of Ornithology and Mammalogy, U. S. Department of Agriculture.

1907. Hawks and owls from the standpoint of the farmer. Circular No. 61, Biological Survey, U. S. Department of Agriculture.

Kirkpatrick, John. 1859. The rapacious birds of Ohio. Ohio Agriculturist, Report for 1858, pp. 340–383.

Maxwell, Herbert Eustis (Chairman of committee). 1893. Report of the plague of field-voles in Scotland. The Annals of Scottish Natural History, Vol. 2, No. 7.

McAtee, W. L. 1931. A little essay on vermin. Bird-Lore, Nov.-Dec.

Merriam, C. Hart. 1887. Report of the commissioner of agriculture, 1886. U. S. Department of Agriculture.

Middleton, A. D. 1930. Cycles in the numbers of British voles. Journal of Ecology, Vol. 18.

Pearson, T. Gilbert. 1929. The case of the hawk. Circular No. 17, National Association of Audubon Societies.

Piper, Stanley E. 1909. The Nevada mouse plague of 1907–08. Farmer's Bulletin 352. U. S. Department of Agriculture.

Preble, Edward A. 1927. A plea for our hawks. Nature magazine, January.

Quinn, Davis. 1929. "Framing" the birds of prey. New York.

Snyder, L. L. 1932. Hawks and Owls of Ontario. Handbook No. 2, Royal Ontario Museum, Toronto.

Stoddard, Herbert L. 1931. The bob-white quail. New York, 1931. Its habits, preservation and increase. Charles Scribner's Sons.

Stupka, Arthur. 1931. The dietary habits of barn owls. Bulletin No. 6, Bureau of Scientific Research, Division of Conservation, State of Ohio.

Sutton, George Miksch. 1925. A year's program for bird protection. Bulletin No. 7, Board of Game Commissioners, Commonwealth of Pennsylvania.

Trautman, M. B. and Wickliff, E. L. 1931. A key to the vultures, hawks, and eagles of Ohio, together with a brief description of their plumages and habits, and a summary of their economic status. Bulletin No. 5, Bureau of Scientific Research, Division of Conservation, State of Ohio.

Warren, B. H. 1890. Report on the birds of Pennsylvania with special reference to the food habits, based on over four thousand stomach examinations. Harrisburg.

Weed, Clarence M. and Dearborn, Ned. 1924. Birds in their relations to man. Philadelphia.

Wight, H. M. 1931. The effect of pole traps on harmless and beneficial species. The Wilson Bulletin, Vol. XLIII, No. 4, pp. 282–292.

Editor's Note.

It will be of interest to the readers of the above paper to note that the Ohio Academy of Science at its annual meeting in 1932 approved and accepted the following recommendation offered by the Committee on State Parks and Conservation:

"We believe that all persons interested in conservation of our wild life should rally to the support of our birds of prey. Due to popular prejudice resulting in indiscriminate persecution of all species, our birds of prey are rapidly decreasing in numbers, some species being threatened with extermination. The great majority of our predacious species have long since been proven to be beneficial in their food-habits, while the few species known to be more or less destructive are so reduced in numbers that any damage attributable to them is negligible.

We recommend that all birds of prey be protected by law, subject to the right of any citizen to control them when in the act of destroying his property.

We further believe that the pole-trap is a wasteful and inhuman means of capturing birds of prey, since it not only does not discriminate between injurious and beneficial species of predacious birds, but also destroys large numbers of song-birds and game mammals. We therefore recommend that legislation be enacted making use of the pole-trap illegal."